

STUDY GUIDE

MECHANICAL SLUDGE HANDLING

INTRODUCTION AND ADVANCED

SUBCLASS G

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PREFACE

This operator's study guide represents the results of an ambitious program. Operators of wastewater facilities, regulators, educators and local officials, jointly prepared the objectives and exam questions for this subgrade.

The objectives in this study guide have been organized into modules, and within each module they are grouped by major concepts.

HOW TO USE THESE OBJECTIVES WITH REFERENCES

In preparation for the exams, you should:

1. Read all the objectives that apply to the grade level desired and write down the answers to the objectives that readily come to mind.
2. Use the references at the end of the study guide to look-up answers you don't know. This one set of references covers all of the objectives.
3. Write down the answers found in the references to those objectives you could not answer from memory.
4. Review all answered objectives until you can answer each from memory.

IT IS ADVISABLE THAT YOU ATTEND SOME FORM OF FORMAL TRAINING IN THIS PROCESS BEFORE ATTEMPTING THE CERTIFICATION EXAM.

Choosing A Test Date

Before you choose a test date, consider the training opportunities available in your area. A listing of training opportunities and exam dates can be found in the annual DNR "Certified Operator," or by contacting your DNR District operator certification coordinator.



INTRODUCTION

MODULE A: PRINCIPLE, STRUCTURE AND FUNCTION

CONCEPT: PRINCIPLE OF MECHANICAL SLUDGE HANDLING

1. Discuss the purposes of Mechanical Sludge processing.
2. Describe the basic purpose of preconditioning sludge before thickening or dewatering.
3. Discuss the differences between batch processing and continuous sludge handling operations.

CONCEPT: STRUCTURE AND FUNCTION

4. Describe the gravity thickening process, and the percent solids in thickened product.
5. Describe the belt press thickening process, and the percent solids in thickened product.
6. Describe the vacuum filter thickening process, and the percent solids in thickened product.
7. Explain the wet air oxidation process (Zimpro).
8. Describe the air flotation thickening process, including, percent solids capture and percent solids in thickened product.
9. Describe the frame press thickening process, and percent solids in thickened product.
10. Identify the locations in a Mechanical Sludge Handling plant that should have ventilation equipment.
11. List the types of pumps used for Mechanical Sludge handling.

MODULE B: OPERATION AND MAINTENANCE

CONCEPT: OPERATION

12. Explain the purpose of the following chemicals used for sludge conditioning:
 - A. Polymers
 - B. Ferric Chloride
 - C. Lime
 - D. Hydrogen Peroxide
 - E. Soda Ash
 - F. Sulfuric Acid
13. Describe the physical appearance of sludge at the following solids concentrations:
 - A. 5 percent
 - B. 15 percent
 - C. 40 percent
14. Discuss the operating procedures that will help maintain the quality of the sludge product.
15. State the importance of sludge blanket depth measurement in gravity thickening.
16. List the data needed to evaluate pumping rates from a gravity thickener.
17. Describe the relationship of the depth of the sludge blanket to pumping rates while under routine operating conditions.
18. Describe how to change the flow rates for the following equipment:
 - A. Piston Pump (Positive Displacement)
 - B. Progressive Cavity Pump
 - C. Diaphragm Pump (Positive Displacement)
 - D. Telescoping Valves and Sludge Pits
19. List the operational measurements the operator must accurately take for the following equipment:
 - A. Chemical Feed Pumps
 - B. Sludge Pumps
 - C. Sludge Density Meters

20. Explain the reasons why secondary sludge should be aerated if being stored.
21. Discuss the relationship of sludge pH to odor control and pathogen content.
22. List three purposes for ventilation regarding the following:
 - A. Safety
 - B. Odor Control
 - C. Corrosion Prevention
23. List two operating strategies that will reduce the harmful effects caused by return streams on wastewater treatment.
24. List the factors that affect the costs of operating Mechanical Sludge Handling equipment.
25. Compare direct hauling of sludge versus hauling dewatered sludge.
26. Compare direct land spreading of sludge to the incorporation of sludge into the soil.
27. List the sludge qualities that make its disposal difficult.
28. Describe the qualities that improve public acceptance of sludge end-products.

CONCEPT: MAINTENANCE

29. List three major categories of maintenance.
30. List three major categories of equipment information operators should have for a planned maintenance program.
31. Discuss special housekeeping and maintenance considerations associated with Mechanical Sludge Handling.

MODULE C: MONITORING AND TROUBLESHOOTING

CONCEPT: MONITORING

32. Describe the laboratory equipment needed to test for solids content.

33. Describe the sampling locations and sampling frequency necessary to ensure good sludge thickening/dewatering operations.
34. Discuss how to determine volume and solids content of sludge being pumped.
35. Describe the jar test and its uses.
36. List two methods of sludge blanket measurement.
37. Describe the primary monitoring test used in sludge thickening/dewatering processes.
38. Describe the difficulty in determining average moisture content in quantities of sludge, and describe ways to compensate for the difficulties.
39. Discuss tests and measurements that should be run on return streams, and the importance of this flow on plant operations.
40. List the problems associated with sludge flow measurement, and of obtaining representative samples for lab tests.

CONCEPT: TROUBLESHOOTING

41. Discuss the possible causes of odor at a Mechanical Sludge Handling plant.
42. Explain the potential damage to equipment if proper start-up and shut-down procedures are not followed in operation of:
 - A. Wet Air Oxidation
 - B. Incineration
 - C. Positive Displacement Pump
43. List the various operational problems that can be expected from the sidestream return flow.

MODULE D: SAFETY AND CALCULATION

CONCEPT: SAFETY

44. Outline a safety training program designed to avoid the following hazards associated with sludge handling:
 - A. Suffocation and Toxic Gases
 - B. Bumps, Slips and Falls
 - C. Fires and Explosions
 - D. Eye Injury
 - E. Infections
 - F. Getting Caught in Slow Moving Equipment
45. Describe the special safety considerations for the following:
 - A. Centrifuge
 - B. Belts in Belt Presses
 - C. Sludge and Scum Pipelines
46. List the elements that should be included in any emergency plan.
47. List the possible hazards at a treatment plant that would merit an emergency plan.
48. Describe the safe storage requirements and personal hazards in handling the following chemicals:
 - A. Powdered Chemicals(In General)
 - B. Lime
 - C. Alum
 - D. Ferric Chloride
 - E. Polymers.
 - F. Acids(In General)

CONCEPT: CALCULATION

49. Given data, calculate the proper setting for a chemical feed pump in gallons per minute.
50. Given data, calculate the pounds of chemical to feed for a given sludge volume.

51. Given data, calculate the pounds of dry solids in a given sludge.
52. Given data, calculate solids loading in dry tons.
53. Given data, calculate the wet sludge in tons when % solids and dry tons are known.
54. Given data, calculate the percentage solids capture of a thickening process.
55. Given data, calculate the "mass balance" of solids, in gallons.
56. Given data, calculate the percent volume reduction through a solids handling process.



ADVANCED

MODULE A: PRINCIPLE, STRUCTURE AND FUNCTION

CONCEPT: PRINCIPLE OF MECHANICAL SLUDGE HANDLING

1. Describe the sources of organic sludge and where it is collected, stored or treated, within a treatment plant.
2. List some characteristics of dewatered sludge.
3. List the characteristics of dewatered sludge that cause it to have limited public acceptance.
4. List some of the ultimate uses of dewatered sludge.
5. Define Bound and Unbound Water as related to sludge dewatering.
6. Explain how various types of treatment affects the fuel value of sludge.

CONCEPT: STRUCTURE AND FUNCTION

7. Describe all Mechanical processes available for thickening and dewatering sludge.
8. Discuss the performance goals that are expected of each Mechanical thickening and dewatering process.
9. List all possible sidestreams in a treatment plant.

MODULE B: OPERATION AND MAINTENANCE

CONCEPT: OPERATION

10. Outline the characteristics, dewaterability, and operational adjustments, necessary for the following generated sludges:
 - A. Primary Sludge
 - B. Aerobic Sludge
 - C. Anaerobic Sludge
 - D. Wet Air Oxidized Sludge
11. List the characteristics of stable sludge.
12. List the characteristics of unstable sludge.
13. Describe the conditions that would produce unstable sludge, and the problems it could cause.
14. Discuss where and when sidestreams should be returned relative to BOD and suspended solids content.
15. List the factors that affect sidestream quality.
16. Describe how sidestream quality is related to total solids concentration of end product sludge.
17. List the alternatives that can be implemented to lessen sidestream impact on treatment plant processes.
18. Explain how sidestream quality affects plant final effluent quality.
19. Outline ways that the quality of sidestreams can be improved.
20. Explain the effect of chemical addition on sludge.
21. Identify the Mechanical Sludge Handling processes that might have the higher values of polymer dosage.
22. Explain the mechanism by which pH adjustments can be used to condition sludge and make it dewaterable.
23. Explain the reasons for pH adjustment, and the process to effectively reduce pathogens in sludge.

24. Discuss how the pH of sludge influences the type of polymer used, and how to select a polymer.
25. Describe the variables to consider when predicting the amount of waste activated sludge produced for thickening.
26. Compare the performance and costs of mechanical dewatering vs. liquid hauling listing advantages and disadvantages of each.
27. Develop a written daily plan to evaluate a belt press for optimum performance.
28. Describe the criteria used by an operator to evaluate the performance of Mechanical thickening and dewatering processes.
29. List the conditions which determine whether a sludge should be dewatered or hauled as a liquid.
30. List the advantages of hauling dewatered or thickened sludge, rather than liquid sludge.
31. Describe any possible advantages in hauling liquid sludge, rather than dewatered sludge.
32. Explain what information is needed to determine the cost effectiveness of a sludge handling process.
33. List the alternatives to consider if landfill costs were to increase significantly.
34. List some operational strategies that can be used to eliminate the problems that limit public acceptance of dewatered sludge.
35. Discuss the kinds of information that should be exchanged between different crews and work shifts concerning sludge handling equipment.
36. Discuss the need and ways in which information can be communicated between diverse groups of operators at a treatment plant.

CONCEPT: MAINTENANCE

37. Outline the elements that should be included in a preventive maintenance program.
38. List some reasons for a preventive maintenance program for Mechanical Sludge Handling equipment.

39. Outline the steps necessary for setting up a preventive maintenance program, and where to locate necessary information.
40. List the important elements of a lubrication program.
41. List the components of a "three card system" of preventive maintenance.

MODULE C: MONITORING AND TROUBLESHOOTING

CONCEPT: MONITORING

42. Describe the alternatives to field testing of equipment that could be taken to evaluate the selection of sludge handling equipment.
43. List the expected sidestream value ranges for BOD and Suspended Solids for the following processes:
 - A. Gravity Sludge Thickeners
 - B. Wet Air Oxidation (Zimpro)
 - C. Vacuum Filters.
 - D. Dissolved Air Flotation (DAF) Units
 - E. Gravity Belt Thickeners
 - F. Belt Press Thickeners
44. Explain the purpose of a bench test.
45. Explain why a good bench test might not translate into successful operation.
46. Briefly describe the following bench tests:
 - A. Specific Resistance Test (Buchner Funnel Method)
 - B. Filter Leaf Test
 - C. Capillary Suction Time
 - D. Jar Test

CONCEPT: TROUBLESHOOTING

47. Describe how odor problems can generally be eliminated.
48. Explain the conditions which contribute to the production of hydrogen sulfide gas.

49. Explain how generation of hydrogen sulfide gas can be controlled.
50. Discuss the problems associated with hydrogen sulfide gas.
51. Describe the problems associated with low pH sludge.
52. Describe the problems associated with high pH sludge.

MODULE D: SAFETY AND CALCULATIONS

CONCEPT: SAFETY

53. List the hazards associated with operating and maintaining mechanical sludge dewatering equipment.
54. Describe how hazards associated with operating mechanical sludge handling equipment can be reduced through the following:
 - A. Education
 - B. Good housekeeping
 - C. Proper maintenance
 - D. Use of protective equipment
 - E. Changes in employee attitudes about safety
55. List the emergency measures that should be taken in the event of the following:
 - A. Fire
 - B. Explosion
 - C. Serious personal injury
56. Describe the safe storage requirements and personal hazards in handling the following chemicals:
 - A. Powdered Chemicals (In General)
 - B. Lime
 - C. Alum
 - D. Ferric Chloride
 - E. Polymers
 - F. Acids (In General)

CONCEPT: CALCULATIONS

57. Given data, find the cost of operating a belt press in cost per dry ton of processed sludge.
58. Given data, calculate the cost comparison of hauling sludge at different concentrations.
59. Given data, calculate the increased loading of suspended solids (or BOD) to a treatment plant due to the return of sidestreams from dewatering equipment.
60. Given data, calculate polymer dosage in lbs/ton at effective bench test dosage, and gallons fed at a given dilution.
61. Given data on jar testing of a diluted polymer, calculate the number of gallons needed to precondition a volume of sludge from the jar testing.
62. Given data on chemical dilutions used for jar testing, calculate the effective concentration in mg/L, and the pounds of chemical needed to treat a volume of sludge.

RESOURCES

1. ADVANCED WASTE TREATMENT. 1st Edition (1987), Kenneth D. Kerri. California State University, 6000 J Street, Sacramento, CA 95819-6025. Phone (916) 278-6142.
2. CONTROLLING WASTEWATER TREATMENT PROCESSES. (1984). Cortinovis, Dan. Ridgeline Press, 1136 Orchard Road, Lafayette, CA 94549.
3. DEWATERING MUNICIPAL WASTEWATER SLUDGES. Design Manual EPA 626/1-85-014 (1982). U.S. Environmental Protection Agency, Office of Research and Development, Municipal Environmental Research Laboratory, Cincinnati, OH 45268.
4. OPERATION AND MAINTENANCE OF SLUDGE DEWATERING SYSTEMS. Manual of Practice OM-8 (MOP OM-8) (1987). Water Environment Federation (Old WPCF), 601 Wythe Street, Alexandria, VA 22314-1994. Phone (800) 666-0206.
5. OPERATION OF MUNICIPAL WASTEWATER TREATMENT PLANTS. Manual of Practice No.11(MOP 11), 2nd Addition (1990), Volumes I, II, and III. Water Environment Federation (Old WPCF), 601 Wythe Street, Alexandria, VA 22314-1994. Phone (800) 666-0206. (MOP 11, 1976 can still be used as a reference)
6. OPERATION OF WASTEWATER TREATMENT PLANTS. 3rd Edition (1990), Volumes 1 and 2, Kenneth D. Kerri, California State University, 6000 J Street, Sacramento, CA 95819-6025. Phone (916) 278-6142.
7. SLUDGE DEWATERING. Manual of Practice No.20 (MOP-20) (1983). Water Environment Federation (Old WPCF), 601 Wythe Street, Alexandria, VA 22314-1994. Phone (800) 666-0206.